大同大學 97 學年度研究所碩士班入學考試試題

考試科目：電子學　　所別：電機工程研究所　　

註：本次考試 不可以參考自己的書籍及筆記； 不可以使用字典； 可以使用計算器。

1. Consider the circuit shown in Fig. 1.

   (a) For both BJTs Q1 and Q2, $\alpha_1 = \alpha_2 = \alpha$, $I_{S1} = I_{S2} = I_S$, derive an expression for I_{c1} and I_{c2} in terms of α, I_{EE}, V_{id} (=V_{i1}- V_{i2}) and V_T(=kT/q) …etc. (10%)

   (b) Show that $\Delta I_c = I_{c1} - I_{c2} = \alpha I_{EE} \tanh(\frac{V_{id}}{2V_T})$. (6%)

2. (a) Draw the small-signal equivalent circuit for Fig. 2. (include body effect for Q1) (3%)

   (b) Derive the voltage gain $A_v = v_o/v_i$. (8%)

   (c) Let W/L=100μm/2μm for all n-MOS, $\mu_n C_{ox}$=100 μA/V^2, I_{REF}=100μA, 1/λ=12V and $g_{mb} = \chi g_m$, χ=0.15. Calculate $A_v = v_o/v_i$. (6%)

3. Consider the differential amplifier shown in Fig. 3, where $(W/L)_1=(W/L)_2$=100, $(W/L)_{B1}$=10, $(W/L)_{B2}$=100, $\mu_n C_{ox}$=100μA/V^2, and V_{tn}=0.6V. For DC bias calculations, neglect channel-length modulation and body effects.

   (a) If the input common-mode voltage V_{CM} is 1.5V, calculate V_P. (4%)

   (b) If the input common-mode voltage V_{CM} is 1.5V, determine the output swing range. (4%)

   (c) Find the lowest value of V_{CM} for which M_{B2} remains in saturation region. (4%)

   (d) Determine the low-frequency differential voltage gain [$(v_{o1}- v_{o2}) /v_d$]. (4%)

   (e) Estimate the –3dB frequency in Hz. (4%)

   (f) Determine the common-mode gain for v_{o1} due to the finite drain resistance of M_{B2}. (λ= 0.05 V^{-1}) (5%)

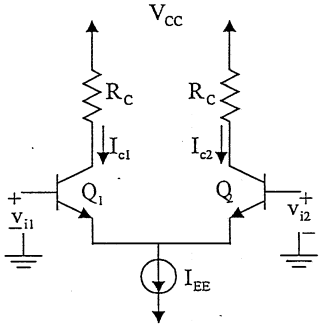

Fig. 1

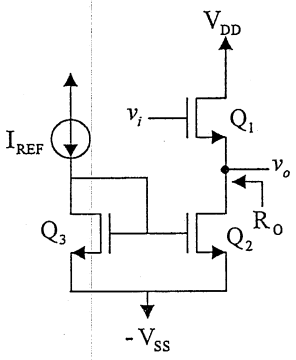

Fig. 2

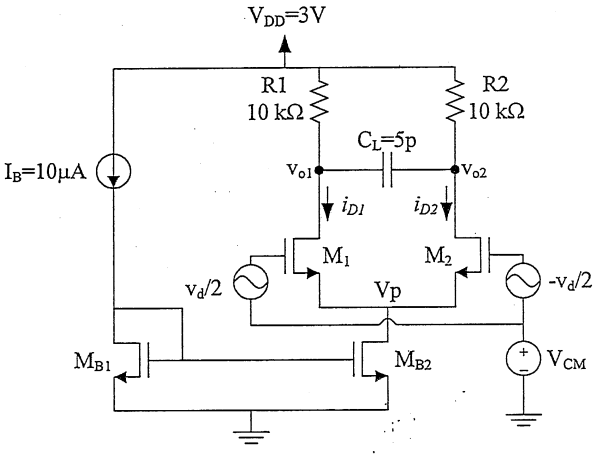

Fig. 3

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4. Consider the circuit shown in Fig. 4, where $(W/L)_1=16$, $(W/L)_2=2.5$, $\mu_nC_{ox}=2.5\times\mu_pC_{ox}=100\mu A/V^2$ and $V_{tn}=-V_{tp}=0.6V$. Neglect channel-length modulation effect.

   (a) Calculate the small-signal voltage gain of the circuit. (4%)

   (b) Calculate the pole associate with node X. Neglect the gate capacitance of M_1. (4%)

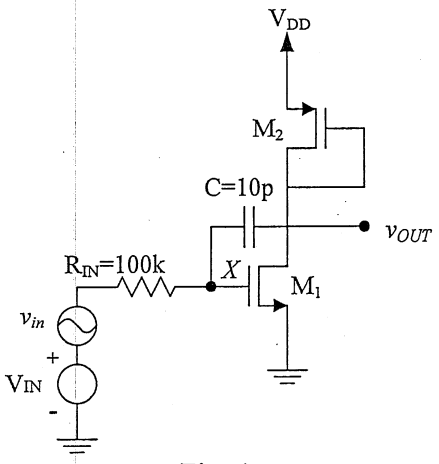

Fig. 4

5. A simplified TTL inverter is shown in Fig. 5. Assume $\beta_F = 50$ and $\beta_R = 0.2$.

   (a) Calculate the power supply currents for $V_{in} = 0.1$ V and $V_{in} = 4$ V. (10%)

   (b) State the mode of operation for each transistor in both cases. (6%)

6. Find all the voltages at all the nodes for the pass transistor circuit of Fig. 6 neglecting the body effect. Assume $V_{tn} = |V_{tp}| = 0.4$ V. (18%)

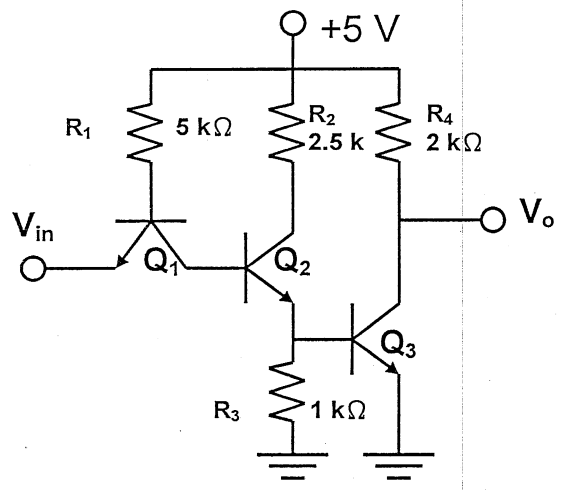

Fig. 5

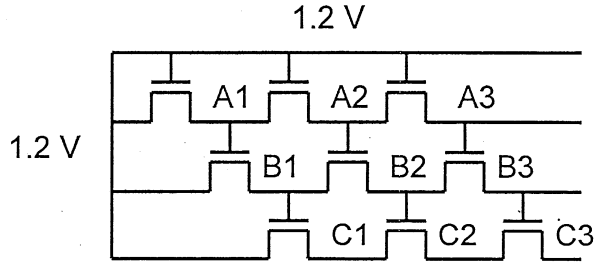

Fig. 6